CORE FOR ABSORBENT ARTICLES AND METHOD OF MAKING THE SAME

FIELD OF THE INVENTION

This invention relates to absorbent articles. More particularly, it relates to absorbent cores for absorbent articles wherein the core comprises an expanded tow having on its surface a superabsorbent polymer.

BACKGROUND OF THE INVENTION

The use of absorbent articles, such as protective undergarments, has increased steadily for many years. Early uses, such as diapers for babies and sanitary products for women, have in recent years been joined by an increasing demand for products designed to deal with incontinence issues for adults, frequently brought on by advanced age, obesity, or a variety of medical conditions. At the same time, markets have grown in all of these areas for both disposable and reusable products, depending on the preferences of the consumer.

Currently available absorbent articles usually include superabsorbent polymers (SAP). These materials are capable of absorbing a large quantity of body fluid, such as urine, blood, and menses, and thus have become the standard for absorbent articles for hygiene purposes.

One example of the use of SAP is described in U.S. Patent No. 5,641,561 to Hansen et al. There are described absorbent composites made of fibrous material (e.g. cellulosic or synthetic material) and particulate superabsorbent polymers that are bound to the fiber via hydrogen bonding binder molecules. Superabsorbent polymer particles are mixed as particles with bleached kraft fluff, heated and spread out to dry. The binder adheres the SAP particles to the fibers. The dried product is then fed through a hammermill and shunted to an airlay line to produce a web containing 40% SAP particles attached to individual fibers.

U.S. Patent No. 5,593,399 to Tanzer discloses an absorbent article, namely a diaper, having two layers attached by an adhesive to provide attached zones and unattached zones to form pocket regions. Tanzer describes the use of SAP particles located within the pocket regions of the article to provide an absorbent laminate. The pocket regions are arranged in a non-contiguous and labyrinth configuration.

There is an ever-increasing demand for thinner absorbent articles that nonetheless have high fluid absorption capacity. Unfortunately, some conventional absorbent articles tend to be bulky.

Whitmore et al., in U.S. Pat. No. 6,417,425, describe absorbent articles including an absorbent core and an acquisition layer designed to afford rapid uptake of fluid, good transfer properties, good uptake upon repeated insults with fluid, and good skin compatibility. The acquisition layer, which also has absorbent capabilities, is prepared by a process that includes spraying onto a fibrous web a blend containing superabsorbent polymer particles, superabsorbent-forming monomer, initiator and water, and subjecting the web to polymerization conditions. In the '425 patent, there is stated the belief that the absorbent structure performs well as an acquisition layer in a disposable diaper because the swelling of the superabsorbent polymer particles is capable of expanding the fibrous web, so that the interstitial pore volume of the web increases after an insult of liquid.

Despite the foregoing developments, however, there remains a need for improved absorbent articles.

SUMMARY OF THE INVENTION

According to one aspect of the invention, an absorbent core is provided for use in an absorbent article. The core includes a plurality of substantially continuous and coextensive filaments, at least some of the filaments having disposed on a surface thereof a layer comprising a superabsorbent material formed in place on the surface from a liquid superabsorbent polymer.

According to another aspect of the invention, a method of making an absorbent core for use in an absorbent article is provided. The method includes expanding a tow comprising a plurality of substantially continuous and coextensive filaments, each filament having a surface. The method also includes forming, from a liquid superabsorbent polymer, a layer comprising a superabsorbent material on the surface of at least some of the filaments.

According to yet another aspect of the invention, a system is provided for making an absorbent core for use in an absorbent article. The system includes means for applying a liquid superabsorbent polymer to a tow comprising a plurality of substantially continuous and coextensive filaments,

thereby forming a treated expanded tow comprising a liquid superabsorbent polymer coating on the surface of at least some of the filaments. Means is provided for forming, from the liquid superabsorbent polymer coating, a layer comprising a superabsorbent material on the surface of at least some of the filaments.

BRIEF DESCRIPTION OF THE FIGURES

Figure 1 is a side view of an embodiment of a tow material configured to form a component of an absorbent core according to an aspect of this invention.

Figure 2 is a side view of the tow material shown in Figure 1 after it has been expanded according to an aspect of this invention.

Figure 3 is a side view of the expanded tow material shown in Figure 2 with treated and untreated filaments.

Figure 4 is a schematic representation of an embodiment of a system for forming an absorbent core according to an aspect of this invention.

Figure 5 is a schematic representation of another embodiment of a system for forming an absorbent core according to an aspect of this invention.

DETAILED DESCRIPTION OF THE INVENTION

Although the invention is illustrated and described herein with reference to specific embodiments, the invention is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the invention.

In one exemplary aspect, the invention provides an absorbent core for use in an absorbent article. The core comprises a plurality of filaments in the form of an expanded tow, and a layer comprising a superabsorbent material on surfaces of the filaments. In another exemplary aspect, the invention provides method of making an absorbent core for use in an absorbent article. The method includes providing a tow comprising a plurality of filaments, partially separating the filaments to afford an expanded tow, and providing a layer comprising a superabsorbent material on surfaces of the filaments.

Absorbent cores according to one exemplary embodiment of the invention may find particular utility in the preparation of absorbent articles

such as protective undergarments. These may include, for example, protective underwear, training pants, adult briefs, diapers, incontinence pads, and feminine hygiene pads. The absorbent articles may be disposable, or the cores may be disposable items removably incorporated in re-usable articles.

Absorbent cores according to one exemplary embodiment of the invention are pulpless and therefore less bulky. In addition, the use of expanded tow instead of pulp may advantageously afford a softer, more flexible texture, providing a more cloth-like, comfortable feel for the wearer.

The invention will next be illustrated with reference to the figures, wherein the same numbers indicate the same elements in all figures. Such figures are intended to be illustrative rather than limiting and are included herewith to facilitate the explanation of the present invention. The figures are not to scale, and are not intended as engineering drawings.

Referring in general to Figures 1-5, an absorbent core 210 is provided for use in an absorbent article. The core 10, 110, 210 includes a plurality of substantially continuous and coextensive filaments 12, 112, 212, at least some of the filaments 218 having disposed on a surface thereof a layer comprising a superabsorbent material formed in place on the surface from a liquid superabsorbent polymer.

The filaments 12, 112, 212 can be selected from RAYON, cellulose acetate, polypropylene, polyethylene, polyethylene terephthalate, and sheath-core bi-component filaments, for example, and combinations thereof. At least some of the filaments 12, 112, 212 can include cellulose acetate, and the surface of at least some of the filaments can be hydrophilized. Substantially all of the filaments 218 optionally have disposed on the surface thereof the layer comprising the superabsorbent material.

The absorbent core 210 optionally includes two or more adjacent and coextensive strata, wherein one stratum includes filaments 218 having disposed on the surface thereof the layer comprising the superabsorbent material, and another stratum is substantially free of superabsorbent material (e.g., filaments 212). The stratum that is substantially free of superabsorbent material optionally includes a surfactant disposed on the surface of at least some of the filaments.

Where the core 210 is provided with two opposing sides, the superabsorbent material is optionally disposed in a pattern on one or both of the opposing sides. The core 210 optionally includes pulp fibers interspersed between at least some of the filaments 12, 112, 212, and superabsorbent polymer particles are optionally interspersed among at least some of the filaments 12, 112, 212.

In an exemplary method of making an absorbent core 210 for use in an absorbent article, tow 10 is expanded and a layer comprising a superabsorbent material is formed on the surface of at least some of the filaments 12, 112, 212.

The forming step is optionally performed by applying to the expanded tow 110 the liquid superabsorbent polymer to form a treated expanded tow comprising a liquid superabsorbent polymer coating, followed by curing the treated expanded tow to form the layer comprising the superabsorbent material. The applying step is optionally performed by immersing the expanded tow 110 in a bath 44 holding the liquid superabsorbent polymer, removing the expanded tow 110 from the bath 44, and removing a portion of the liquid superabsorbent polymer coating. The applying step alternatively includes spraying liquid superabsorbent polymer on at least one surface of the expanded tow 110. The curing step can be accomplished by exposing the treated expanded tow to heat or to radiation.

The step of forming a layer of superabsorbent material can be completed by patternwise spraying liquid superabsorbent polymer on one or both of the sides of the tow 110 or by spraying the liquid superabsorbent polymer on one of the sides and applying a surfactant to at least some of the filaments on the other side.

The filaments 12, 112, 212 can be partially separated to form the expanded tow 110 by, for example, blowing the tow 10 with jets of air. The tow can also be at least partially flattened. After the layer-forming step, one or both of water and residual volatile reactants can be removed from the formed layer. Also, the filaments can be tenderized.

Pulp fibers and/or superabsorbent polymer particles are optionally interspersed between at least some of the filaments 12, 112, 212, and at least

some of the filaments 12, 112, 212 can be hydrophilized. The forming step optionally includes forming a layer on selected filaments 218 or on substantially all of the filaments.

According to yet another aspect of the invention, a system is provided for making an absorbent core 210 for use in an absorbent article. The system includes means, such as a bath 44 or a spray nozzle 50, 52, for applying a liquid superabsorbent polymer to a tow 10 comprising a plurality of substantially continuous and coextensive filaments 12, 112, 212, thereby forming a treated expanded tow comprising a liquid superabsorbent polymer coating on the surface of at least some of the filaments. Means 46, such as a heater or radiation source, is provided for forming, from the liquid superabsorbent polymer coating, a layer comprising a superabsorbent material on the surface of at least some of the filaments.

Where the core includes two opposing sides, and the means for applying optionally includes a spray nozzle 50, 52 configured to apply the liquid superabsorbent polymer on one or both of the sides in a pattern. Means can also be provided for applying a surfactant to the expanded tow 110.

Means 45 are optionally provided for removing a portion of the liquid superabsorbent polymer coating, for interspersing pulp fibers between at least some of the filaments, for interspersing superabsorbent polymer particles between at least some of the filaments, for flattening the tow (e.g., fiber spreader 42), for partially separating filaments of the tow (e.g., jets of air formed by air jet 43), for removing one or both of water and residual volatile reactants from the formed layer (e.g., dryer 47), and for tenderizing the filaments (e.g., tenderizing unit 48).

Referring now to Figure 1, there is shown a side cross section view of a tow, generally indicated at 10, suitable for use in practicing one exemplary aspect of the invention. The tow 10 comprises a plurality of filaments 12 that are substantially continuous and coextensive. Between the filaments 12 are small interstitial spaces 14. Such tow 10 may be formed from RAYON, cellulose acetate, polypropylene, polyethylene, polyethylene terephthalate, or any other polymeric material known in the art, for example sheath-core bi-component filaments.

To improve coating of a liquid superabsorbent polymer (to be described later) onto tow 10 comprising otherwise hydrophobic filaments such as for example polypropylene, polyethylene, and polyethylene terephthalate, the filaments may be hydrophilized. This may be done for example by treatment with silica, treatment with a material which has a suitable hydrophilic moiety and is not readily removable from the filament, or by sheathing the nonwettable, hydrophobic filament with a hydrophilic polymer during or after the formation of the filament. Alternatively, the surface of the filaments may be treated with for example a corona discharge, to afford surface hydrogen-bondable groups and thereby increase hydrophilicity.

A combination of these filament types may also be used, and may be intermixed or layered. In some cases, it may be advantageous to use both hydrophilic and hydrophobic filaments, in order to control the distribution of liquid superabsorbent polymer to certain filaments (the hydrophilic ones), as well as to exert control over the flow of urine or other body fluids in the core when used. The exemplary filaments may have a denier per filament of between 3 and 1000 grams/9000 m, preferably between about 10 and about 70 grams/9000 m. A combination of filament deniers may also be used, and may be intermixed or layered. The exemplary filaments may be shaped to increase loft, for example by flat or helical crimping. The filaments are substantially independent of each other; that is, they are not bonded together to any significant degree.

Figure 2 shows, as a side cross section view, tow 110 after it has been expanded, by means to be discussed later. The resultant expanded tow 110 may be substantially wider than it is thick, thus forming a core. Between filaments 112 are large interstitial spaces 116, such that the entire expanded tow 110 has an open structure conducive to the transport of bodily fluids, as well as a soft feel due to the open, puffy structure.

Figure 3 shows a side cross section of an absorbent core 210 according to one exemplary embodiment of the invention in which an expanded tow 110 (Fig. 2) has been treated on one side with a superabsorbent material to afford a layer of that material over at least selected surfaces of the filaments 218. The superabsorbent material, details of which will be discussed below, is essentially

free of particulate superabsorbent material in this exemplary embodiment.

Treated filaments 218, indicated by broad lines, may be concentrated on one side of the absorbent core 210, while untreated filaments 212 are on the other side, in the embodiment shown in Figure 3. In order for there to be sufficient absorbency in the core, at least about 5% of the total combined surface area of the filaments may be treated. Preferred is at least about 50%, and still more preferred is at least about 80%. Although the treated filaments 218 are shown as each being completely covered with superabsorbent polymer, some or all of them may be only partially covered. Also, although Figure 3 shows two relatively well-defined strata consisting of treated filaments 218 and untreated filaments 212 respectively, there may instead be a gradual transition from one to the other across the thickness of absorbent core 210. Alternatively, all of the filaments may be treated with superabsorbent polymer, which may be beneficial when maximum absorbency is desired.

Such an embodiment of the invention may help overcome a problem commonly encountered in traditional absorbent articles, namely the phenomenon of "gel blocking". In this situation, the otherwise porous structure of an article employing particulate superabsorbent polymers becomes occluded due to swelling of the particles when they imbibe bodily fluids. Upon exposure to another flow of liquid, the article may not be able to handle the additional demand quickly enough, and overflow occurs. This may result in leakage of fluid out of the article, wetting the wearer's clothing.

When a fluid contacts the superabsorbent material in the embodiment shown in Figure 3, the material swells. However, due to the open structure created by the interstitial spaces 216, gel blocking does not occur. Thus, when a second insult of liquid is applied to the core in use, the flow of liquid is not occluded. This diminishes the chances of fluid overrunning an area of the article and wetting a user's clothing, while at the same time ensuring that more nearly all of the superabsorbent material is accessible to the fluid. This increases effective capacity for fluid absorption.

According to an exemplary embodiment of the invention, treatment of the expanded tow 110 to afford a layer of superabsorbent material is performed by application of a liquid superabsorbent polymer. As used herein,

the term "liquid superabsorbent polymer" means one or more superabsorbent polymers at least partially dissolved in a liquid carrier, or a solution in a liquid carrier of one or more superabsorbent precursors, or a combination of one or more superabsorbent polymers and superabsorbent precursors. Such precursors include, inter alia, monomers that are subsequently oligomerized, polymerized, and/or crosslinked after placement on a substrate to form superabsorbent polymers. It may sometimes be advantageous to include particulate superabsorbent polymers in such a formulation, for example if increased absorbency is desired.

Alternatively, using only nonparticulate materials may be preferred in cases where it is desired to reduce shake-out of particulate matter, or shifting of absorbency within the article due to shifting of some of the superabsorbent particles. Both of these phenomena lead to inefficient superabsorbent polymer use, requiring the addition of more superabsorbent to compensate. These problems are largely avoided by the use of liquid superabsorbent polymers, which attach more firmly to the substrate. The issues of shake-out and shifting are of particular importance when tow is used in combination with particulate superabsorbents, because the spacing between fibers is much greater than that encountered in traditional cores employing pulp and superabsorbent polymer particles. In these traditional systems, the pulp fibers help keep the superabsorbent particles in place to a greater degree than is the case with expanded tow 110.

Numerous liquid superabsorbent polymers are known in the art. Nonlimiting examples of these, suitable for use with this invention, follow.

U.S. Patent No. 4,944,963 to Dabi, incorporated herein by reference, describes forming a terpolymer of methyl methacrylate, acrylic acid, and glycidyl methacrylate, which is subsequently neutralized. The resulting solution is applied to a fibrous substrate in the aqueous form. Excess solution is removed by vacuum, and the treated substrate is heated for 20 minutes at 120°C to create a structure comprising substrate fibers on the surface of which is a crosslinked superabsorbent polymer.

U.S. Patent No. 5,853,867 to Harada, incorporated herein by reference, describes a cationic absorbent polymer applied to a fibrous substrate as a

monomer solution, with the monomer subsequently being polymerized on the substrate by heating. Alternatively, preformed polymer may be applied. Halogenated alkyl quaternary salts of dialkylamino (meth)acrylates are effectively used for the production of the polymers, and include the halogenated alkyl quaternary salts of such monomers as N,N-dimethylaminoethyl (meth)acrylate, N,N-dimethylaminopropyl (meth)acrylate, N,N-diethylaminobutyl (meth)acrylate, N,N-diethylaminoethyl (meth)acrylate, and N,N-diethylaminopropyl(meth)acrylate, for example. As used here, the term "(meth)acrylate" means that either an acrylate or a methacrylate is suitable. Such a cationic absorbent polymer may be applied in a suitable liquid form such as, for example, by spraying or spreading a solution of polymer onto the substrate. Preferably, fixation of cationic absorbent polymer to the substrate is attained by depositing a monomer or mixture of monomers in the form of an aqueous solution on the substrate, and polymerizing the monomers in the applied layer of monomer solution.

Another suitable liquid superabsorbent polymer is disclosed in U.S. Pat. No. 6,417,425 to Whitmore et al., incorporated herein by reference. There is described a sprayable composition comprising a monomer such as acrylic acid, methacrylic acid, and/or salts of these; a crosslinker such as ethoxylated and propoxylated trimethylolpropanetriacrylate derivatives (such as SR-9035 and SR-492, available from Sartomer Co., Inc. of Exton, Pa.); and a polymerization initiator such as 2,2'-azobis(2-(2-imidazole-2-yl))propane dihydrochloride, all in aqueous solution. Also included in the composition are solid superabsorbent particles. The mixture can be sprayed onto a fibrous substrate and subsequently cured via heating or exposure to electron-beam or ultraviolet radiation, to form a superabsorbent polymer matrix.

For the purposes of this invention, a liquid superabsorbent polymer may be applied to the expanded tow 110 by any means known in the art. Examples of suitable means include spraying, dipping, and gravure application. A preferred method, in the case where it is desired to cover substantially all of the available filament surface, is to submerge the tow in a bath of liquid superabsorbent polymer (item 44 in Figure 4), remove the tow from the bath, and remove excess liquid superabsorbent polymer by means of blowing with a

jet of air, or several jets. Such a method affords particularly facile and rapid coverage of the filaments.

Application may be performed such that an entire surface of the absorbent core is treated, or may be performed in a pattern of treated and untreated areas. Application may be from only one side or both sides of the absorbent core, and may or may not extend through the entire thickness of the core.

The layer of superabsorbent polymer may be substantially continuous over the surface of the filaments, rather than in discrete clumps, thereby maximizing the available surface area per unit weight of superabsorbent polymer. In order to facilitate spreading of the liquid superabsorbent polymer over the surface of the filaments, surface modification techniques such as for example corona discharge treatment may be applied to the filaments. Alternatively, or in addition, the use of hydrophilic lubricants or surfactants may facilitate even distribution of the liquid superabsorbent polymer. Such methods are for example disclosed by Phillips et al in U.S. Pat. No. 5,972,505, where polyethylene terephthalate filaments are treated with one of the following materials, all available from ICI Americas, Inc.:

Hypermer A109, a modified polyester surfactant

Brij 35, a polyoxyethylene (23) lauryl ether

Brij 99, a polyoxyethylene (20) oleyl ether

G-1300, a polyoxyethylene glyceride ester (nonionic surfactant)

G-1350, a polyoxyethylene-polyoxypropylene sorbitan linoleic phthalic ester.

Figure 4 shows an example of an overall process for preparing a core for incorporation into an absorbent article, according to the invention. Cellulose acetate or other tow is provided as a bale 41; the tow consists essentially of continuous filaments of fiber packed together into a tight bundle. Tow 41 is fed into fiber spreader 42, where the tow is spread apart by rollers to form a somewhat flattened shape. The spread fibers are then fed into an air jet fiber opener 43, where the tow may be significantly opened up by turbulent, high-pressure air, for example. Optionally, fibers such as pulp, cotton linters, pieces of filament, or other short fibrous material may also be incorporated into the

opened-up or expanded tow, for example by inclusion in the stream of air from the air jet fiber opener, or by other means. Particulate superabsorbent polymer may also be introduced into the expanded tow in this manner.

The opened-up tow may then be submerged in a bath 44 of liquid superabsorbent polymer, optionally also containing superabsorbent particles. In the embodiment where tow is used without the addition of short fibers or particulate superabsorbent polymer by blowing in (or other means) as described above, there is reduced contamination of the bath with pieces of filament, since tow filaments are essentially continuous. Submersion in this manner may afford a high and uniform loading of liquid superabsorbent polymer, penetrating through the entire core. This may in some cases be advantageous, especially for thicker (higher basis weight) cores.

Alternatively, lighter and/or somewhat one-sided application may be favored for some applications. In such a case, application of the liquid superabsorbent polymer may instead be done for example by spraying, or by application using a gravure roller. Other means are known to those skilled in the coating art.

The process of Figure 4 is particularly suitable for cases were the opened-up tow is of higher basis weight, for example in the range of about 30 gsm to about 500 gsm (grams/sq. meter), in order to achieve maximum penetration of the liquid superabsorbent polymer into the core. It may however be used for cores of any basis weight.

Excess liquid superabsorbent polymer may then be blown off of the expanded tow using a compressed air source 45, for example, with the blown-off material being recycled back into the bath 44, reducing wastage of superabsorbent material. Air source 45 may be one or more air jets, and may be applied from one or both sides of the core, with various degrees of force or pressure. This may provide means for tuning or adjusting the loading profile of superabsorbent polymer as a function of position in the core, i.e. to provide and/or adjust a gradient of liquid superabsorbent polymer as a function of depth. Such adjustment may be designed to provide one or more strong gradients, or to minimize gradients and thereby give a more uniform profile of superabsorbent polymer with depth.

The thus-coated filaments are then passed through a curing unit 46, which causes polymerization and/or crosslinking reactions to occur with the reactive ingredients of the liquid superabsorbent polymer, thereby forming a superabsorbent polymer on surfaces of the filaments. Curing unit 46 may for example be a heating unit, an ultraviolet light source, or an electron beam source, as appropriate depending upon the type of liquid superabsorbent polymer used.

The resulting "finished" tow is then passed through a dryer 47 to remove water and/or residual volatile reactants, and then into a tenderizing unit 48, which crimps and/or bends the coated filaments in order to soften them, overcoming some of the stiffness imparted by the presence of the superabsorbent layer. Finally, the resulting "soft-finished" coated tow may be fed into a rotary die cutter 49, where it is cut to size to fit the dimensions of a desired absorbent article.

Figure 5 shows an alternative process for preparing a core according to the invention. A process generally like that described in relation to Figure 4 is used, with the exception that application of the liquid superabsorbent polymer is performed with an upper sprayer 50 and a lower sprayer 52, which may afford coverage of both sides of the core and therefore tend to improve penetration of the liquid superabsorbent polymer into it, as compared to spraying on only one side. The method of Figure 5 may be particularly appropriate for lower basis weight cores, for example those in the range of about 5 gsm to about 30 gsm. It may however be used for cores of any basis weight. Air jets (not shown) may also be used either after applying the liquid superabsorbent polymer, or simultaneously with it, to modify or adjust the distribution of superabsorbent polymer in the core.

In another exemplary embodiment of the invention, the method detailed in Figure 5 may be modified by eliminating one of sprayers 50 or 52. By using such an approach, a core may be prepared in which superabsorbent polymer is concentrated on one side of the core, with little or no superabsorbent on the opposing side. The result of this is the formation, in a single structure, of regions that perform respectively the functions of absorbency and liquid transfer. Thus the opposing side, having little or no superabsorbent, may be

placed nearer the user's skin, and perform the function of an acquisition-distribution layer. This may obviate the need for a separate acquisition-distribution layer, but it may also be used in combination with such a separate layer. Air jets (not shown) may also be used either after applying the liquid superabsorbent polymer, or simultaneously with it, to modify or adjust the distribution of superabsorbent polymer in the core.

Depending upon the amount of liquid superabsorbent polymer sprayed onto the filaments, and the pressure of the spray as it impinges the core, it is possible to vary the total loading of the superabsorbent polymer and the profile of its distribution through the thickness of the core. Thus for example a relatively large amount of superabsorbent polymer sprayed at a high pressure will tend to result in deeper penetration into the core. It will be readily appreciated that various combinations of spray volume and pressure will result in various gradients of superabsorbent polymer loading through the thickness of the core, such that the absorbency and other properties of the product can be tailored to meet particular needs. Standard air jet nozzles and other equipment for such spraying operations are well known, and spraying pressures may for example vary from about 1 to about 100 PSIG (pounds/sq. inch, gage).

In yet another exemplary embodiment of the invention, referring again to Figure 5, one of the sprayers 50 and 52 may apply a liquid superabsorbent polymer while the other applies a surfactant solution. The surfactant-treated side of the core will thereby have increased wettability, improving its ability to act as an acquisition-distribution layer. Sufficient surfactant amount and spray pressure may be applied to allow significant surfactant to reach the opposite side, where the liquid superabsorbent polymer is applied, or conditions may be chosen to reduce such penetration, depending upon the needs of the particular absorbent article to be produced. Air jets (not shown) may also be used either after applying the liquid superabsorbent polymer, or simultaneously with it, to modify or adjust the distribution of superabsorbent polymer and/or surfactant in the core.

The absorbent cores of the invention are particularly suitable for incorporation into absorbent articles for use in protective undergarments. Such

a core may be used alone or in combination with another core of similar construction, or one of a traditional construction comprising for example kraft fluff and particulate superabsorbent polymer. Depending on cost, performance requirements, particular uses, and manufacturing considerations, various designs and materials of construction can be selected for use in assembling such undergarments. U.S. Patent No. 6,004,893 to Van Tilburg, which is incorporated herein by reference, describes a variety of such materials and associated constructions.

For example, absorbent cores may be enwrapped with17.1-gsm tissue from Cellu Tissue Corporation, East Hartford, Conn. The enwrapping tends to improve wicking of fluid across more nearly the full width and length of the core. It may be C-folded around the core, or layered on top of and/or below the core.

Absorbent cores may also be provided with a topsheet over the enwrapping (if used). The topsheet is liquid permeable and, when the article is in use, is in close proximity to the skin of the user. If used, the topsheet is preferably compliant, soft feeling and non-irritating to the user's skin. Such topsheets can be made from any of the materials conventional for this type of use, for example a 15.0 gsm spunbond polypropylene nonwoven from Avgol Nonwoven Industries, located in Holon, Israel.

One particularly suitable material for the topsheet is for example a 17-gsm wettable nonwoven coverstock, made of thermal bond polypropylene, available from PGI Nonwovens, Landisville, NJ. Other non-limiting examples of suitable materials that can be used as a topsheet are woven and non-woven polyester, polypropylene, polyethylene, NYLON, and RAYON and formed thermoplastic films. Suitable films are described, for example, in U.S. Patent No. 4,324,246 to Mullane and Smith and U.S. Patent No. 4,342,314 to Radel and Thompson, both of which patents are incorporated herein by reference. Formed films may be selected for the topsheet because they are permeable to liquids and yet non-absorbent. Thus, the surface of the formed film, which is in contact with the body, remains substantially dry and is more comfortable to the wearer.

If a topsheet is used, its inner surface may be secured in contacting

relation to the absorbent core. This contacting relationship results in liquid penetrating the topsheet faster than if it were not in contact with the absorbent core. The topsheet can be maintained in contact with the absorbent core by applying adhesive, optionally in spaced, limited areas, to an inner surface of the topsheet. Examples of suitable adhesives used for this purpose include the acrylic emulsion E-1833BT manufactured by Rohm and Haas Company of Philadelphia, PA and acrylic emulsions manufactured by H. B. Fuller Company of St. Paul, MINN. Also contemplated are thermoplastic hot melt adhesives such as 34-563A, available from National Starch, Inc.

Optionally, before a topsheet is applied, a fluid acquisition layer (not shown) may be attached adjacent and coextensive with the absorbent core, on the side of the core nearer the wearer, to improve distribution of bodily fluid more evenly over the full width and length of the core. A topsheet may then be affixed on top of the fluid acquisition layer. Such a layer serves to manage, transport, accommodate and/or direct high volumes and high flow rates of urine into the core. The fluid-acquisition layer can be a through-air bonded/carded web, a spun-bond bi-component non-woven web, a web of cross-linked cellulosic fibers, apertured 3D film or the like. One particular suitable material is available from PGI Nonwovens, Landisville, NJ, and has an overall basis weight of 40 gsm, with high denier (10 denier) bi-component fibers situated on the top (facing the topsheet) and low denier (6 denier) bi-component fibers situated on the bottom (facing the core). The bi-component fibers are made of a polypropylene inner core and polyethylene outer sheath. The fluid-acquisition layer may be adhesively secured in place by any suitable construction adhesive or hydrophilic adhesive, e.g. Cycloflex adhesive available from National Starch and Chemical, Bridgewater, NJ

In the exemplary embodiment of the invention shown in Figure 3, where treated filaments are concentrated to one side of the core and untreated filaments predominate on the other side, the untreated side may itself act to effectively distribute fluids, making the use of a separate acquisition layer unnecessary.

Crotch portions of protective undergarments employing an absorbent core of this invention may comprise a barrier layer made of a material that is

impermeable to liquids and thus prevents bodily fluids and feces from soiling the clothing of the user. Any material used in the art for such purposes can be utilized herein. Suitable materials include, for example, embossed or non-embossed polyethylene and polypropylene films and laminated tissue and non-woven materials.

Optionally, the impermeable barrier layer may be affixed substantially coextensive and parallel with the side of the absorbent core farther from the wearer, to prevent wetting or soiling of clothing. Suitable barrier layers may for example be a liquid-impervious laminate comprising a soft nonwoven (cloth-like/hydrophobic) on the outside and fluid-impervious film (low gauge poly) on the inside. An example of this is a poly laminate available from Clopay Plastic Products Company, Cincinnati, Ohio, which consists of 0.6 mil polyethylene film and 17 gsm SMS (spunbond/meltblown/spunbond) nonwoven. Another version is a poly laminate 9B-396 available from Pliant Corporation of Newport News, Va., which consists of 0.3 mil copolymer film and 14 gsm SBPP (spunbond polypropylene) nonwoven. However, other laminate variations may be used in various gages and basis weights. For instance, other polymers (polypropylene, olefins, polyester, co-extruded polymers, etc.) or coatings (adhesive, synthetic rubber, latex, polyurethane, etc.) can be used in place of the polyethylene film. Other material components (polypropylene, polyethylene, bi-component fibers, polyester, cotton, rayon, nylon, olefins, etc.) can be used in either woven or nonwoven (spunbond, thermal bond, through-air bond, etc.) construction in place of the SMS outer cover. The preferred fluid-impervious film for the liquid-impervious laminate is a breathable 0.8 mil polyethylene version, which contains calcium carbonate, available from Tredegar Film Products, Richmond, VA. This material allows water vapor to pass through it, but does not permit the liquid itself to pass through it.

While preferred embodiments of the invention have been shown and described herein, it will be understood that such embodiments are provided by way of example only. Numerous variations, changes and substitutions will occur to those skilled in the art without departing from the spirit of the invention. Accordingly, it is intended that the appended claims cover all such variations as fall within the spirit and scope of the invention.